patients (25 men and 18 women, age 54 ± 15) who underwent cardiac mass removal with the help of intraoperative TEE were reviewed. Pathological examination disclosed myxoma in 16, metastatic carcinoma in 8, thrombus in 6, fibroelastoma in 6, sarcoma in 3 and other masses in 4. Twelve patients were asymptomatic (28%), 10 presented with congestive heart failure (23%), 8 with cerebrovascular events (19%), 8 with vena cava compression syndromes (14%), 4 with chest pain (9%) and 3 with fever (7%). In 25 patients (58%), symptoms were related to the mass, while the remaining 18 patients (42%), were either asymptomatic (12.28%) or had cardiac symptoms unrelated to the mass (6.14%). The pre-bypass TEE confirmed the location and attachment site of the masses prior to cannulation and incision. In addition, based upon information obtained from the pre-bypass TEE, 1 patient (2%) underwent mitral anuloplasty because of a dilated mitral anulus, 3 patients (7%) underwent closure of a patent foramen ovale and in 1 patient (2%) the TEE helped to determine the site of inferior vena caval cannulation relative to a right atrial rhabdomyoma. Based on the post-bypass TEE, 2 patients (5%) went back on bypass for valve repair (1 mitral anuloplasty and 1 aortic valvuloplasty), because of significant regurgitation. The postbypass TEE identified small residua of large benign masses in 2 patients and reassured the surgeon regarding the completeness of surgical removal and integrity of cardiac structures. In the present patient cohort, the information from the intraoperative TEE (1) confirmed anatomical location and attachment site of the masses prior to cannulation and incision, (2) modified the planned surgical procedure in 7 cases (16%) and (3) reassured the surgeon regarding the success of the operation before the patient left the operating room in the remaining 36 cases.

916-81 Determinants of Tricuspid Regurgitation in Primary Pulmonary Hypertension

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Primary pulmonary hypertension (PPH) is often associated with functional tricuspid regurgitation (TR). However, the severity of TR varies widely from patient to patient. To determine the factors associated with severe TR, we evaluated color flow Doppler assessments of TR, two-dimensional and echocardiographic measures of right ventricular (RV) structure and function, and hemodynamic data in 81 patients with PPH. All patients had NYHA Class III or Class IV symptoms. The severity of TR was quantified as the TR/RA ratio, defined as the ratio of the maximum area of the color flow Doppler jet to right atrial area in the apical four-chamber view. TR was classified as severe when TR/RA ratio ≥0.34.

Severe TR was observed in 28 patients, 51 patients had less than severe TR, and two patients had no detectable TR. There were no significant differences between patients with and without severe TR when compared for body size, functional class, mean or systolic pulmonary artery pressure, TR peak velocity by continuous wave Doppler, or RV percent change in area (an index of RV systolic function). Patients with severe TR had greater tricuspid annular dimension (4.1 ± 0.5 vs. 3.7 ± 0.7 cm, $p < 0.05$), greater RV minor axis dimension (5.8 ± 0.7 vs. 5.3 ± 0.2 cm, $p < 0.05$), and greater ratio of the RV minor axis to RV major axis dimensions (0.80 ± 0.02 vs. 0.69 ± 0.02, $p < 0.01$).

These results suggest that functional TR is common in patients with symptomatic PPH, and that severe TR is observed primarily in patients with RV remodeling and tricuspid annular dilatation.

916-82 Quantitative Analysis of Patent Ductus Arteriosus Shunt by Transesophageal Imaging of the Flow Convergence Region

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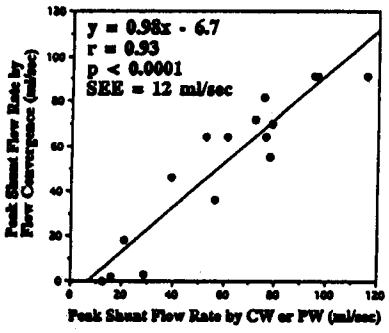
We used biplane and multiplane transesophageal echo (TEE) to develop methods to detect and quantitate patent ductus arteriosus (PDA) shunts in 26 patients with isolated PDA (age: 1 mo–37 yrs, weight: 4.0–67 kg). Flow convergence signal was a good marker for identifying the location of PDA. The maximum axial distance of the first color alias ductal flow convergence region (FCR) from the intimal line of the descending aorta was measured. Using the simple hemispherical isovelocity surface assumption, peak shunt flow (Q ml/sec) rates were calculated ($Q = 2\pi r^2 \times V$, where r (cm) = the maximal distance of the flow convergence and V (cm/sec) = the aliasing velocity used for imaging of the flow convergence). The same peak shunt flow rate was also calculated as the product of the CW or high PRF pulsed Doppler peak velocity of the shunt flow and the corresponding smallest PDA area imaged which was $\pi \times (D/2)^2$, where D = the (smallest) diameter of the ductus. Peak shunt flow rates calculated by the flow convergence method agreed well with those derived from the conventional CW or pulsed Doppler velocity-time integral. In 2 patients for whom cardiac catheterization was performed, shunt flow volumes/minute calculated by oximetry and the Fick principle agreed well with those obtained by FCR (6.3 vs. 6.0 l/min and 7.5 vs 7.1 l/min, respectively).



Conclusion: Quantitative assessment of ductal shunt flow is feasible using TEE.

917 Stress Echocardiography

Sunday, March 16, 1997, 5:00 p.m.–7:00 p.m.
Anaheim Convention Center, Hall E
Presentation Hour: 5:00 p.m.–7:00 p.m.

917-51 Dobutamine Stress Has Remained Safe and Effective Despite Use of More Aggressive Protocols: Experience with 3011 Patients

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The indications and protocol of dobutamine stress echocardiography (DbE) have evolved over 5 years of clinical use. The influence of these changes on safety and efficacy were studied in 3011 pts (age 66 ± 12 y, 3706 men). All underwent incremental Db stress from 5 to 40 μg/kg/min, followed by an additional stage of 50 μg/kg/min, handgrip and/or atropine (to 2 mg) if required. Findings were recorded at each stage and pts monitored for 6 min into recovery.

Results: DbE was performed for diagnosis of CAD in 30%, assessment of known CAD in 32%, and preoperative risk stratification in 38%. In the overall group, 85% attained target heart-rate or an ischemic endpoint; atropine was required in 30%. Dose-limiting side-effects occurred in 8%, with serious complications (ventricular tachycardia, myocardial infarction) in 0.2%. Neither ventricular fibrillation nor death occurred. Over 5 years, the use of DbE for risk stratification increased, and more aggressive protocols were used to obtain higher levels of stress but the frequency of dose-limiting side-effects was less, probably because of stricter endpoint criteria;

	1991–3	1994	1995	p
Preoperative testing	30%	37%	44%	<0.001
Proportion given atropine	13%	34%	39%	<0.001
Mean Db dose (mcg)	34 ± 9	37 ± 7	39 ± 7	<0.001
Target HR > 85% max	59%	76%	80%	<0.001
Dose-limiting side-effects	13%	7%	4%	<0.001

Conclusions: Despite use of more aggressive protocols in pts with other medical problems, Db stress remains safe and highly effective.

917-52 Clinical Significance of ST Segment Elevation During Dobutamine Stress Echocardiography: Correlation with Coronary Angiography

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Significance of ST segment elevation (ST↑) during exercise stress testing is well document. Prevalence and significance of ST↑ during dobutamine stress (DSE) echocardiography is not well documented. We found ST↑ in 28 of the 426 consecutive patients (incidence 4.4%) undergoing DSE. We prospectively examined the echocardiographic (ECHO) and angiographic correlates in these subjects. Of the 28 subjects, 19 were male and 9 were

female with the mean age of 59 years. They had undergone DSE for evaluation of angina or preoperative risk assessment. Dobutamine infusion was continued until either the target heart rate was achieved or the patient developed symptoms. Atropine (0.1 to 0.2 mg) was used to achieve the target heart rate if required. Eleven of the 28 patients had ECHO evidence of previous myocardial infarction. Twenty five of 28 patients developed ST↑ in inferior leads. ST↑ in anterior leads was seen in 3 patients. In addition, 8 patients also developed ST↑ in lateral precordial leads. None developed significant arrhythmias. ECHO showed a worsening of the existing wall motion abnormality or development of a new wall motion abnormally in 23 patients. Coronary angiography results were available in 20 patients and showed, 3 vessel disease in 11, 2 vessel disease in 7 and 1 vessel disease in 2 patients. Significant stenosis was always present in the vessel supplying the area coinciding with ECG ST↑. In conclusion, 1) dobutamine induced ST↑ is associated with development of new ECHO wall motion abnormalities. 2) ST↑ occurred in the artery with the significant narrowing even in patients with 3 vessel disease. 3] ST↑ seems to indicate exaggeration of ischemia in the hypoperfused viable myocardium. 4] ST↑ during DSE is not associated with serious arrhythmias.

917-53 Prognostic Value of Biphasic Response during Dobutamine Stress Echo after Myocardial Infarction

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Background: dobutamine stress echocardiography (DSE) is used to identify resting function (at baseline), myocardial viability (at low dose) and ischemia (peak dose up to 40 μg with atropine up to 1 mg). Patients (pts) with left ventricular dysfunction after myocardial infarction (MI) and myocardium which is still viable may exhibit a biphasic response during DSE (improved wall thickening at low dose and worsening at peak dose). *Objective:* to assess incidence of cardiac events in patients with viable dyssynergic myocardial regions and biphasic response during DSE after MI. *Methods:* 84 pts (49 male) with a mean age of 59 ± 9 after a first uncomplicated MI underwent DSE within one month after discharge. A standard 16 segments model and 4 point scoring system was used for analysis (WMSI). A biphasic response was defined as ≥2 segments with improved wall thickening at low dose and worsening at peak dose dobutamine. All patients underwent coronary angiography. Patients were followed-up for 18 ± 12 months. *Results:* Based on DSE result patients were divided in two groups, Group A (46 pts) with biphasic response and Group B (38 pts) with no biphasic response. The events in the two groups were:

	EF (%)	WMSI basal	Death Re-MI	Angina CABG PTCA	Tot. events (%)
GrA	46 ± 8	1.49 ± 0.33	6 (13%)	18 (39%)	24 (52)*
GrB	49 ± 10	1.38 ± 0.26	0	8 (21%)	8 (21)*

* $p < 0.05$;

Age, gender and multivessels disease did not differ in the two groups. There were a light difference in EF and WMSI between the two groups without any statistical significance. *Conclusion:* biphasic response during DSE is able to predict cardiac events in pts with residual viable myocardium after a MI and to identify high risk patients in the follow-up.

917-54 Post-Treadmill Versus Supine Bicycle Exercise Echocardiography in Detecting Myocardial Ischemia: A Randomized, Single-Blind Crossover Trial

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The comparative accuracy of supine bicycle (SB) and post-treadmill (TM) exercise echocardiography in detecting myocardial ischemia has not been previously evaluated in the same patients (pts). Accordingly, 46 pts (40 males; age 58 ± 9 yrs) referred for evaluation of coronary disease underwent SB echo (starting at 25–50 W with 25 W increment every 3 min) and post-TM (Bruce protocol) echo in a random sequence. Digitized images at baseline and peak exercise were interpreted in a random order by a blinded observer using a 16 segment LV model. Maximal heart rate was higher during TM (133 ± 22 vs 118 ± 21 bpm) while systolic blood pressure was higher during SB (176 ± 29 vs 158 ± 25 mmHg; both $p < 0.01$), resulting in a similar double product. At quantitative angiography, 35 pts had coronary stenosis (> 50%). During SB, ischemia (new or worsening wall motion abnormality) was detected in 25 of 35 pts (71%) compared to 21 pts (60%) by TM. The extent of myocardial ischemia (number of ischemic segments) was higher during SB compared to TM (4.8 ± 2.9 vs 3.4 ± 2.4 segments; $p = 0.05$) while severity of abnormal wall motion was similar. The sensitivity of SB and TM for CAD (ischemia or scar) was 77% and 74%, with a specificity of 91 and 82%, respectively. Image quality was similar with both techniques. Pts favored SB over TM (70% vs 24%; $p < 0.001$). *Conclusion:* During SB and TM exercise, pts achieve a similar double product. However, the detection of ischemia is more frequent and more extensive during SB echocardiography, which, along with patient preference, makes SB an attractive stress echo modality.

917-55 Three-Dimensional Mapping of Myocardial Velocity Gradient: a New Approach to Quantify Regional Left Ventricular Contractile Reserve

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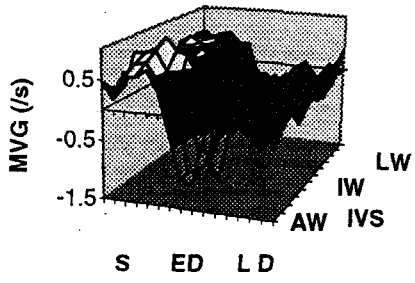
To determine whether three-dimensional (3D) reconstruction of left ventricular myocardial velocity gradient (MVG) can quantify myocardial contractile reserve during low-dose Dobutamine Stress Echo (DSE) 14 pts. (age 61 ± 11 yrs) with coronary artery disease (CAD) and 16 age-matched normals were studied. 3D reconstruction of MVG was created from sequential apical 2D Doppler Tissue Images acquired at 15º step according to ECG and respiration gating (TomTec Echo-Scan). It allowed to create 3D map of MVG in the whole left ventricle and its changes during the cardiac cycle. Each LV wall (anterior – AW, inferior – IW, lateral wall – LW, septum – IVS) was divided into three segments (from base to apex) and MVG was measured for each segment (see graph). Finally, MVG measurements were correlated with semiquantitative wall motion score (WMS) before and after DSE.



Results: In viable segments MVG increased during ventricular ejection (0.3 ± 0.2 s^{-1} vs. 0.7 ± 0.3 s^{-1}; $p < 0.01$) and rapid ventricular filling (0.2 ± 0.3 s^{-1} vs. 0.6 ± 0.4 s^{-1}; $p < 0.01$). Good correlation was found between MVG and WMS before ($r = 0.92$; $p < 0.001$) and after ($r = 094$; $p < 0.001$) DSE. *Conclusions:* 3D MVG is a promising new approach to quantify regional myocardial ischaemia or viability.

917-56 Prognostic Value of Routine Serial Bicycle Exercise Echocardiography After Coronary Artery Bypass Grafting

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To determine the prognostic value of serial bicycle exercise echocardiography (EE) in patients with prior coronary bypass grafting (CABG), five-year clinical follow-up was obtained in 99 consecutive patients (79 men, 20 women, age 60 ± 8 years) who had at least two serial EE after CABG. Regional wall motion (WM) was graded using a 16 segment model and WM scores were derived for each stage of the test. During a mean follow-up of 60 months, 25 patients had major events (death, myocardial infarction [MI], repeat CABG) and 23 had minor events (angioplasty, unstable angina, heart failure). Forty-six of 87 (53%) patients with an abnormal EE (abnormal baseline or stress-induced WM abnormality) had an event compared to 2 of 12 (18%) with normal EE ($p = 0.03$). Twenty-eight of 47 (60%) patients with a stress induced WM had an event compared to 2 of 12 (18%) patients with a normal EE ($p = 0.01$). Twenty-four (50%) patients having an event presented with anginal symptoms compared to nine of 51 (18%) patients without an event ($p < 0.002$). *Conclusions:* An abnormal EE and presenting anginal symptoms identify patients at increased risk for cardiac events. Patients with normal EE are at low risk for future MI or death.